

**ENGLISH TRANSLATION OF  
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SPECIFICATION, CLAIMS, ABSTRACT,  
4 SHEETS OF 7 FIGURES AND COVER  
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**Brake disk, especially for a rail vehicle**

**[0001]** The present invention relates to a brake disk, especially for a rail vehicle, according to the preamble of claim 1.

**[0002]** Such brake disks, which are used as "axle-mounted or wheel-mounted brake disks", are subjected during operation to considerable mechanical and thermal stresses, which require special design measures in order to firstly ensure the requisite safety and secondly permit reasonably practicable assembly and dismantling for exchange purposes.

**[0003]** Since the friction rings expand due to the heating which occurs during the braking, simple centering by cylindrical seating on the hubs of axle-mounted brake disks, in particular in the case of two-piece high-performance brake disks, does not suffice. It is therefore known to fasten sliding elements in the form of sliding blocks to the hub, these sliding elements being guided in radial grooves of the respective friction ring, so that the friction ring can certainly expand radially, but the centering is retained by the lateral fixing of the sliding block in the radial groove. This equally applies to wheel-mounted brake disks, in which the friction rings are held on both sides of a wheel disk in a centered and rotationally locked manner.

**[0004]** The sliding blocks therefore prevent a radial displacement of the respective friction ring from occurring due to the applied braking torque or due to dynamic shocks, thereby possibly resulting in inadmissible unbalance.

**[0005]** In addition, friction rings made of ductile materials, for example steel, may shrink during operation due to plasticization processes in the friction surfaces, caused by high braking power and high temperatures. In this case, the friction rings, for exchange, can no longer be released from the hub without any problems.

**[0006]** The sliding blocks are also used in order to prevent this, so that the friction rings, as mentioned, can expand or shrink concentrically, the cylindrical play between the friction disk and the hub being designed to be correspondingly large for this purpose.

**[0007]** The use of such sliding blocks in wheel-mounted brake disks is known, for example, from EP 0 683 331 B1, EP 0 589 408 B1, EP 0 644 349 B1, DE 197 27 333 C2 and DE 100 47 980 C2.

**[0008]** The solution, shown and described therein, to the problems described by means of sliding blocks has proved successful in principle. However, the realization of these connections is only possible at a relatively high production cost, which precludes optimized manufacture from the cost point of view.

**[0009]** Furthermore, only a very small number of sliding blocks are used, normally three to six, which are dimensioned to be correspondingly large on account of the requisite load absorption and therefore take up a large amount of space. An additional drawback is non-uniform load transmission together with the resulting stresses due to the known arrangement and design of the sliding blocks.

**[0010]** The conventional dimensioning of the width of the sliding blocks (about 15-60 mm) leads to an increase in play of the sliding guide, that is to say of the radial grooves, due to the temperature differences which occur during operation of the brake disk. This temperature difference between radial groove and sliding block may amount to several hundred degrees C in friction rings. For example, a groove width  $b_N = 20$  mm and a temperature difference  $\Delta T = 200$  K may be assumed. Thus:

**[0011]** 
$$\Delta b = b \cdot \alpha_{th} \cdot \Delta T = 20 \cdot 10^{-5} \cdot 200 \text{ K} = 0.04 \text{ mm}$$

**[0012]** This value appears to be small, but in the case of friction ring masses of about 100 kg (average size) means unbalance of  $U = m \cdot e = 4 \text{ gm}$  ( $e$  = eccentricity). This value already amounts to more than half the admissible unbalance in the case of high-performance brake disks.

**[0013]** As already mentioned, it is very costly to make the radial grooves and the sliding blocks, especially by the requisite machining.

**[0014]** The object of the present invention is therefore to further develop a brake disk of the generic type in such a way that its operability is improved and more cost-effective manufacture is made possible.

**[0015]** This object is achieved by a brake disk which has the features of claim 1.

**[0016]** The invention permits for the first time, instead of a few sliding element guides, a larger number of "miniature sliding element guides" which prevent, for example, the disadvantages described with reference to the prior art with regard to different expansions of the sliding elements and of the radial grooves

with the consequences arising therefrom. To this extent, the invention offers a noticeable improvement in operating safety, in particular since no appreciable unbalance is produced in this connection.

**[00017]** The manufacture of the brake disk also becomes simpler and more cost-effective due to the invention. If the sliding elements are actually produced, i.e. machined, from a semi-finished product or a standard part, this can be done with little outlay. This equally applies to the incorporation of the radial grooves in the friction ring, it being possible for said radial grooves to be produced with very little outlay.

**[00018]** According to an advantageous development of the invention, provision is made for a radial groove and an engaging guide pin to be assigned to each clamping bolt, with which the friction ring is fastened to the hub, the respective radial groove, starting from a through-hole for passing the through-bolt through, is extended outward or inward toward the center longitudinal axis of the hub. In each case, the incorporation of the radial groove in this region is especially simple.

**[00019]** Due to the small dimensions of the guide pins forming the sliding elements, in particular with regard to the cross-sectional dimensions, and an accompanying reduction in play during heating between the guide pin and the radial groove, an improved centering effect is achieved.

**[00020]** Whereas the play mentioned with respect to the prior art and caused by temperature differences is, for example, 0.04 mm, at a groove width of 20 mm, this play, with a guide pin inserted and at a width of the radial groove of 5-10 mm, is reduced to 0.01-0.02 mm, so that the quality of the centering is more than doubled.

**[00021]** The guide pins are expediently inserted into holes of the hub in the case of an axle-mounted brake disk or into holes of the wheel disk in the case of a wheel-mounted brake disk, said holes likewise being kept correspondingly small, so that, despite the larger number, the weakening of the material is slight and the strength of the component is increased. This is especially important in the case of brake disks in which the locating holes are incorporated directly on the wheel web.

**[00022]** The larger number, now possible, of sliding elements forming a form fit permits in interaction with the radial grooves a more uniform transmission of

the braking torque from the friction ring to the hub or the wheel disk. The larger number of friction ring connections also permits the transmission of a higher braking torque, the number of guide pins depending on the proportion of braking torque which is to be transmitted by a form fit.

**[00023]** The arrangement of the guide pins is to be selected according to the number of connecting lugs of the friction ring or of the screwed connections, but are preferably distributed symmetrically, i.e. 3, 6, 9, 12 guide pins are distributed over the circumference.

**[00024]** A form fit between the sliding elements and the radial grooves which can be subjected to high dynamic loading is obtained when the sliding elements, i.e. the guide pins, are of planar design in the region bearing against the side wall of the radial grooves. Contact seating of the friction ring on the hub can thus be dispensed with, with the effect that removal without any problems is possible even in the case of a shrunken friction ring.

**[00025]** Due to the high redundancy which results from the relatively large number of form-fit connections, increased safety of the form fit overall is ensured, which turns out to be an advantage worth mentioning, in particular in the event of a possible incorrect assembly.

**[00026]** The small space required for accommodating the sliding elements on the one hand and for incorporating the radial grooves on the other hand permits the use of these form-fit connections in virtually all types of disk construction.

**[00027]** Further advantageous designs of the invention are characterized in the subclaims.

**[00028]** Exemplary embodiments of the invention are described below with reference to the attached drawings, in which:

**[00029]** figure 1 shows a partial detail of a brake disk according to the invention in a longitudinal section,

**[00030]** figure 2 shows a section through the brake disk according to figure 1 along line II-II in figure 1,

**[00031]** figure 3 shows a further exemplary embodiment of a brake disk in a partial detail shown in longitudinal section,

**[00032]** figure 4 shows a section through the brake disk according to figure 3 along line IV-IV in figure 3,

**[00033]** figures 5 and 6 show further examples of the invention in each case in a

view corresponding to sections II-II and IV-IV, respectively,

**[00034]** figure 7 shows several exemplary embodiments of a detail of the brake disk in each case in a perspective view.

**[00035]** Shown in figures 1 to 6 is an axle-mounted brake disk which in its basic construction consists in each case of a hub 1, having an axially extending hub body 3 and an encircling hub flange 2 extending radially thereto, and of a friction ring 7 which is fastened to the hub 1 by means of clamping bolts 4.

**[00036]** To this end, the clamping bolts 4 are passed through a clamping ring 5 arranged opposite the hub flange 2, through a connecting lug 12, assigned to each clamping bolt 4, of the friction ring 7 and through the hub flange 2, the connecting lug 12 having a through-hole 6 for passing the clamping bolt 4 through and being clamped in place between the clamping ring 5 and the hub flange 2.

**[00037]** A radial groove 11 is provided in the connecting flange 12 in the region of each through-hole 6, this radial groove 11, in the exemplary embodiment shown in figure 1, extending outward starting from the through-hole 6 relative to a pitch circle diameter 13, on which the clamping bolts 4 or the through-holes 6 are arranged in a symmetrically distributed manner.

**[00038]** In the exemplary embodiments according to figures 3 and 4, the respective radial groove 11, likewise starting from the through-hole 6, extends inward toward the center longitudinal axis of the hub 1.

**[00039]** Guided in the radial groove 11 is a sliding element 8 in the form of a guide pin which, with its shank 9, rests in an axially secured manner parallel to the axis of the clamping bolt 4 in an insertion hole 14 of the hub flange 2.

**[00040]** Integrally formed on its free end is a head 10, which in cross section preferably has the shape of a polygon, preferably a square or hexagon, and has at least two opposite parallel sides which bear against the associated side walls of the radial groove 11.

**[00041]** A thermally induced radial expansion of the friction disk 7 is therefore possible without any problems, also because the through-hole 6 of the connecting lug 12 is correspondingly oversized relative to the shank of the clamping bolt 4, so that there is also sufficient play here. On account of the engagement of the sliding elements 8 in the radial grooves 11, centering of the friction disk 7 is always ensured.

**[00042]** It is shown in figures 5 and 6 that the radial groove 11 is arranged outside the through-hole 6, starting from the side facing the hub 1. In this case, the radial groove 11 in the exemplary embodiment according to figure 5 is incorporated in a lug 15 which is integrally formed laterally on the connecting flange 12, ends at a distance from the hub 1 and permits especially simple fitting of the sliding element.

**[00043]** The design of the sliding elements as guide pins is reproduced by way of example in figure 7.

**[00044]** Shown under a) is the simplest form of such a sliding element as a straight pin. A standard part, for example, may be used for this purpose. The example of a sliding element shown by b) corresponds to that in figures 3 and 4, a square head adjoining a cylindrical shank 9 and resting in the respective radial groove of the friction disk 7.

**[00045]** This is likewise the case with the sliding element designated by c), in which the head 10 resting in the radial groove 11 has the cross section of a hexagon. The head 10 of the example d) is designed as a cylinder, as is its shank 9.

**[00046]** The sliding elements b), c) and d) may be produced from a semi-finished product, for example from square, hexagonal or round steel bar, on which the cylindrical shank 9 is turned.

**[00047]** In principle, it is also perfectly possible to use other suitable standard parts or semi-finished products that can be correspondingly machined.